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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

ED 066483

# TECHNICAL REPORT

## ON

## STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

## FOR

## MECHANICAL TECHNOLOGY-TECHNICAL INSTITUTE TRAINING 0-48. and 0-67.

S-321
~~S-607~~

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TM 001 967

U. S. Employment Service
in Cooperation with
New York State Employment Service

November 1964

GATB # 2526

# STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

# MECHANICAL TECHNOLOGY - TECHNICAL INSTITUTE TRAINING 0-48. and 0-67.

S-321
~~S-601~~

## Summary

The General Aptitude Test Battery, B-1002B, was administered to a final sample of 55 male students enrolled in the two-year Mechanical Technology curriculum at the Erie County Technical Institute, Buffalo, New York. This training was established under Title VIII of the National Defense Education Act of 1958. The criterion consisted of grade-point averages. On the basis of mean scores, standard deviations, correlations with the criterion, job analysis data, and their overall selective efficiency, Aptitudes G-Intelligence, S-Spatial Aptitude and P-Form Perception were selected for inclusion in the final test norms.

GATB Norms for Mechanical Technology - Technical Institute Training 0-48. and 0-67., ~~S-601~~ S-321

| B-1001 | | | B-1002 | | |
|---|---|---|---|---|---|
| Aptitude | Tests | Minimum Acceptable Aptitude Score | Aptitude | Tests | Minimum Acceptable Aptitude Score |
| G | CB-1- B<br>CB-1- I<br>CB-1- J | 130 | G | Part 4<br>Part 4<br>Part 6 | 115 |
| S | CB-1- F<br>CB-1- H | 120 | S | Part 3 | 115 |
| P | CB-1- A<br>CB-1- L | 100 | P | Part 5<br>Part 7 | 100 |

## Effectiveness of Norms

The data in Table IV indicate that only 69 percent of the non-test-selected students used for this study were good students; if the students had been test-selected with the above norms, 80 percent would have been good students. 31 percent of the non-test-selected students used for this study were poor students; if the students had been test-selected with the above norms, only 20 percent would have been poor students.

TECHNICAL REPORT

## I. Purpose

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms on the General Aptitude Test Battery in screening applicants for referral to a training curriculum in Mechanical Technology. (These norms may be particularly useful in screening applicants for training established under Title VIII of the National Defense Education Act of 1958.)

## II. Sample

The General Aptitude Test Battery, B-1002B, was administered in March 1962 to 67 senior male students enrolled in a two-year Mechanical Technology curriculum at the Erie County Technical Institute, Buffalo, New York. This training was established under Title VIII of the National Defense Education Act of 1958. Twelve students were eliminated from the sample due to the collection of incomplete test and/or criterion data. Therefore, the final sample consisted of 55 male students who successfully completed the two-year course of study.

The two-year curriculum in Mechanical Technology at the Erie County Technical Institute is accredited by the Engineers Council for Professional Development. Graduates are awarded the Degree of Associate in Applied Science. The requirements for enrollment are: high school graduation; recommendation by high school principal; good high school background in mathematics, physics and mechanical drawing; evidence that the student is physically qualified for the curriculum; acceptance through formal application; qualifying on admission interview and tests.

TABLE I

Mean (M), Standard Deviation ($\sigma$), Range, and Pearson Product-Moment Correlation with the Criterion (r) for Age

| N = 55 | M | $\sigma$ | Range | r |
|---|---|---|---|---|
| Age (years) | 20.1 | 1.1 | 19-27 | .083 |

III. Course Description

Title of Course Curriculum: Mechanical Technology

Summary: The Mechanical Technology curriculum at the Erie County Technical Institute requires two years of instruction. Students spend three quarters of each year in classes and laboratories at the Institute and are employed in industry for the remaining portion of the year. The curriculum provides basic training in the application of the fundamental principles for machine design, tool design, production planning, heat and power equipment, air conditioning and refrigeration equipment, materials testing and industrial instruments. Emphasis is placed on the practical approach to the solution of problems.

Technical Curriculum: The following courses comprise the core of technical subjects in Mechanical Technology:

Mechanical Drafting - Fundamentals of mechanical drafting including lettering, use of instruments, orthographic projection, dimensioning, auxilliary views and sections. Study of intersections and developments; pictorial representations, piping and linkage. Detail and assembly drawings working from actual machine assemblies, making sketches, details and assembly drawings.

Machine Tools - Industrial safety, use of ferrous and non-ferrous materials, types and machinability of steel, use of bench and layout tools, purpose and operation of machine tools, study of cutting tool action and shape. Purpose and principles of milling machines, principle of dividing head. Purpose of grinders, principles in selection of grinding wheels, machine work time factors, mathematical calculations for machine work. Construction and use of turret lathes, automatic screw machines and gear cutting tools.

Physics - Temperature measurement, expansion of materials, heat transfer, gas laws, heat quantities. Fundamental principles of statics in force systems and kinematics, concepts of moment of inertia and centroids of areas.

Strength of Materials - Behavior of materials under effect of types of load, problems of torsion, calculations of flexure and shearing stresses in beams. Performance and reporting on physical tests involving use of physical testing equipment. Study of deflection of beams, design of columns, effect of eccentric loads. Tests on a variety of materials including deflection, impact, column and concrete testing.

Machine and Tool Design - Study of mechanisms, design and stress analysis. Design of straight line and circular bearings, brakes, clutches, belt and chain drives. Study of gears, shafts, couplings, springs, design of cams, completion of design project. Design of cutting tools, jigs, milling fixtures and press tools, principles covering locating, supporting and clamping parts in jigs and fixtures. Use of catalogs in selecting standard tool design accessories.

Heat Power Equipment - Basic principles of thermodynamics, theory of combustion, principles of internal combustion engines. Tests on heat exchanger, centrifugal pump, internal combustion engines.

Air Conditioning and Refrigeration Equipment - Thermodynamics of refrigeration properties of refrigerants, psychometry. Tests on home heating furnaces, refrigeration and air conditioning units.

Instrumentation - Dynamics of fluid flow, law of continuity, flow in pipes and liquid level, fundamental theory and mathematics of automatic controllers, liquid and gas flow measurements, automatic controller calibration and test. Theory of thermoelectric temperature, wheatstone bridge and optical pyrometer. Calibration of pressure gages, checking thermocouples with pyrometers.

Electricity - AC and DC instruments, power, energy torque, electro-magnetism, principles of poly-phase circuits, principles of high-vacuum and gas filled tubes.

Materials - Proper selection, use and treatment of materials in mechanical design. Laboratory work in mechanical properties of materials, use of polishers and microscopes, operation of furnaces, molding machines.

Industrial Hydraulics - Principles and use of industrial oil hydraulics. Examination of hydraulic units and lay-out of hydraulic circuits.

Manufacturing Processes - Theory and discussion course in study of modern manufacturing processes, tooling and equipment.

The subjects in the Mechanical Technology curriculum and the approximate number of classroom and laboratory hours in each subject are as follows:

| Subject | Classroom Hours | Laboratory Hours |
|---|---|---|
| Mechanical Drafting | -- | 220 |
| Machine Tools | 20 | 140 |
| Physics | 120 | -- |
| Strength of Materials | 70 | 50 |
| Machine and Tool Design | 80 | 170 |
| Heat Power Equipment | 40 | 40 |
| Air Conditioning and Refrigeration Equipment | 40 | 40 |
| Instrumentation | 70 | 50 |
| Electricity | 70 | 60 |
| Materials | 40 | 40 |
| Industrial Hydraulics | 40 | 20 |
| Manufacturing Processes | 40 | -- |
| Mathematics | 180 | -- |
| Communication Skills | 140 | -- |
| Sociology, Health Ed., Human Relations, Coordinationg Conferences, Economics | 170 | -- |

The course of study consists of approximately 1120 hours of classroom instruction and 830 hours of laboratory work.

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NOTE: Since technical institute training curriculums usually prepare students for broad categories of technical work rather than

for specific jobs, a specific Dictionary of Occupational Titles classification cannot be assigned to the Mechanical Technology course curriculum. However, the following are titles of positions held by graduates of the Mechanical Technology curriculum at the Erie County Technical Institute, Buffalo, New York:

| | |
|---|---|
| Engine Tester | Materials Testing Technician |
| Engineering Sales Aid | Mechanical Draftsman |
| Field Serviceman | Mechanical Laboratory Technician |
| Instrument Technician | Techanical Salesman |
| Machine Designer | Tool and Die Designer |

IV. Experimental Battery

All the tests of the GATB, B-1002B, were administered to the sample group.

V. Criterion

The criterion data collected consisted of "total" and "refined" grade-point averages. The total grade-point average consisted of the ratio between the total number of honor points earned and the total number of credit hours taken in the two-year course of instruction. Honor points assigned to each letter grade are: A = 4, B = 3, C = 2, D = 1, and F = 0. The refined grade-point average was the student's grade-point average for only the core of technical subjects in Mechanical Technology (see section III of this report). Pearson product-moment correlations were computed between each of the GATB aptitudes and (1) total grade-point averages, and (2) refined grade-point averages. Of these criteria, higher correlations were obtained with the refined grade-point averages. Therefore, refined grade-point averages were used as the final criterion, having a range of 1.95-3.88, a mean of 2.57 and a standard deviation of .46.

## VI. Qualitative and Quantitative Analyses

### A. Qualitative Analysis

On the basis of the job analysis data, the following aptitudes were rated "important" for success in this two-year training curriculum:

Intelligence (G) - required in learning and understanding theory and principles of (1) mechanical, electrical and physical course materials, (2) the function and purpose of tools, and (3) operating complex machinery.

Verbal Aptitude (V) - required in understanding and interpreting written technical material and in preparing technical reports.

Numerical Aptitude (N) - required in preparing diagrams, making computations in design of tools, and making mathematical calculations for courses such as Instrumentation and Strength of Materials.

Spatial Aptitude (S) - required in preparing three-dimensional drawings and designing tools and machinery.

Form Perception (P) - required in making sketches and assembly drawings, in examining hydraulic units and lay-outs of hydraulic circuits, and in making proper selections of mechanical designs.

B. Quantitative Analysis:

TABLE II

Means (M), Standard Deviations (σ), and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N = 55

| Aptitudes | M | σ | r |
|---|---|---|---|
| G-Intelligence | 126.3 | 10.9 | .211 |
| V-Verbal Aptitude | 109.0 | 10.4 | .212 |
| N-Numerical Aptitude | 124.7 | 12.7 | .180 |
| S-Spatial Aptitude | 129.0 | 14.3 | .093 |
| P-Form Perception | 123.7 | 16.7 | .117 |
| Q-Clerical Perception | 115.2 | 14.2 | .150 |
| K-Motor Coordination | 113.6 | 14.5 | .079 |
| F-Finger Dexterity | 107.3 | 16.3 | -.055 |
| M-Manual Dexterity | 117.9 | 19.4 | .069 |

C. Selection of Test Norms:

TABLE III

Summary of Qualitative and Quantitative Data

| Type of Evidence | Aptitudes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | G | V | N | S | P | Q | K | F | M |
| Job Analysis Data | | | | | | | | | |
| Important | X | X | X | X | X | | | | |
| Irrelevant | | | | | | | | | |
| Relatively High Mean | X | | X | X | X | | | | |
| Relatively Low Sigma | X | X | X | | | X | | | |
| Significant Correlation with Criterion | | | | | | | | | |
| Aptitudes to be Considered for Trial Norms | G | V | N | S | P | | | | |

Trial norms consisting of various combinations of Aptitudes S, V, N, S and P with appropriate cutting scores were evaluated against the criterion by means of the Phi Coefficient technique. A comparison of the results showed that B-1002 norms consisting of G-115, S-115 and P-100 had the best selective efficiency.

## VII. Validity of Norms

The validity of the norms was determined by computing a Phi Coefficient between the test norms and the criterion and applying the Chi Square test. The criterion was dichotomized by placing 31 percent of the sample in the low criterion group because this percent was considered to be the unsatisfactory or marginal students.

Table IV shows the relationship between test norms consisting of Aptitudes G, S and P with critical scores of 115, 115 and 100, respectively, and the dichotomized criterion for the experimental sample of students. Individuals in the high criterion group have been designated as "good students" and those in the low criterion group as "poor students."

TABLE IV

Validity of Test Norms for
Mechanical Technology
(G-115, S-115, P-100)

| N = 55 | Non-Qualifying Test Scores | Qualifying Test Scores | Total |
|---|---|---|---|
| Good Students | 6 | 32 | 38 |
| Poor Students | 9 | 8 | 17 |
| Total | 15 | 40 | 55 |

Phi Coefficient = .39
$X^2$ = 8.151
P/2 .005

The data in the above table indicate a significant relationship between the test norms and the criterion for the sample.

## VIII. Conclusions

On the basis of the results of this study, Aptitudes G, S and P with minimum socres of 115, 115 and 100, respectively, have been established as B-1002 norms for selecting students for the two-year Mechanical Technology curriculum described on pages 3-5 of this report. The equivalent B-1001 norms consist of G-120, S-120 and P-100.

## IX. Determination of Occupational Aptitude Pattern

Since a specific (6 digit) Dictionary of Occupational Titles classification cannot be assigned to the two-year curriculum in Mechanical Technology (see pages 4 and 5 of this report), no OAP analysis was made on the data for this study.